FORM PTO-1390 (REV. 5-93) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	JC10 Rec'd PCT/PTO 15 MAR 2002 ATTORNEY'S DOCKET NUMBER **10191/2266**
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	U.S. APPLICATION NO. (If known, see 37 CFR 1 5) 10/088270

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED:
PCT/DE00/03055	**06 September 2000 (06.09.00)**	**15 September 1999 (15.09.99)**

TITLE OF INVENTION
ELECTRONICALLY COMMUTABLE MOTOR HAVING OVERLOAD PROTECTION

APPLICANT(S) FOR DO/EO/US
Joerg SUTTER, Wolfgang SCHWENK and Claude BERLING

Applicant(s) herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U S C 371
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S C 371.
3. ☒ This is an express request to begin national examination procedures (35 U S C 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U S C. 371(b) and PCT Articles 22 and 39(1)
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U S.C. 371(c)(2))
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U S.C 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau)
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made, however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unsigned)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1 97 and 1.98
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☒ A substitute specification and marked-up version of substitute specification.
15. ☐ A change of power of attorney and/or address letter
16. ☒ Other items or information: International Search Report, Preliminary Examination Report and PCT/RO/101.

Express Mail No : EL594613198

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17. ☒ The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search Report has been prepared by the EPO or JPO $890.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) $710.00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $740.00

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,040.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00

				CALCULATIONS	PTO USE ONLY
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 890	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	6 - 20 =	0	X $18.00	$0	
Independent Claims	1 - 3 =	0	X $84.00	$0	
Multiple dependent claim(s) (if applicable)			+ $280.00	$	
TOTAL OF ABOVE CALCULATIONS =				$890	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$890	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$890	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$890	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $____________ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of $890.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

By: [signature] Reg No 35,952

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SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

3/15/02
DATE

10/088270

JC10 Rec'd PCT/PTO 15 MAR 2002

[10191/2266]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Joerg SUTTER et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	ELECTRONICALLY COMMUTABLE MOTOR HAVING OVERLOAD PROTECTION
Art Unit	:	To Be Assigned
Examiner	:	To Be Assigned

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

SIR:

Please amend the above-identified application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

Please cancel original claims 1-7 and please cancel substitute claim 1, without prejudice.

Please add the following new claims:

8. (New) An electronically commutable motor comprising:

output stages feedable from a supply voltage source; and

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an electronic control unit for controlling the output stages using operating PWM control signals, a pulse width of the control signals being reducible as a function of a magnitude of a supply voltage and a specified setpoint such that the motor is protected against overloading, the control signals being determined by a specified operating setpoint up to a nominal voltage of the supply voltage, the pulse width of the control signals being reducible in linear or nonlinear proportion to an increasing supply voltage only upon exceeding the nominal voltage.

9. (New) The motor according to claim 8, wherein the pulse width is reduced at an increasing rate in proportion to an increasing specified setpoint and an increasing supply voltage.

10. (New) The motor according to claim 8, further comprising a correction unit assigned to the control unit that delivers, to the output stages, the control signals determined according to the specified setpoint, either unchanged or as reduced control signals, as a function of the magnitude of the supply voltage.

11. (New) The motor according to claim 10, wherein the control signals are delivered unchanged to the output stages until reaching the nominal voltage, the pulse width being reduced according to a setting provided by the correction unit only when the supply voltage begins to increase.

12. (New) The motor according to claim 10, wherein the correction unit is integrated into the control unit, which delivers the control signals to the output stages, either unchanged or with a reduced pulse width, as a function of the magnitude of the supply voltage.

13. (New) The motor according to claim 8, wherein the reduction of the pulse width of the control signals takes place as a function of a speed of the motor.

Remarks

This Preliminary Amendment cancels without prejudice original claims 1-7 and substitute claim 1 in the underlying PCT Application No. PCT/DE00/03055, and adds

without prejudice new claims 8-13. The new claims conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. § 1.121(b)(3)(iii) and § 1.125(b)(2), a Marked Up Version Of The Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/DE00/03055 includes an International Search Report, dated January 18, 2001. The Search Report includes a list of documents that were uncovered in the underlying PCT Application. A copy of the Search Report accompanies this Preliminary Amendment.

The underlying PCT Application No. PCT/DE00/03055 also includes an International Preliminary Examination Report, dated January 4, 2002, a copy of which is included, including a translation.

Applicants assert that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully Submitted,
KENYON & KENYON

By: [signature] Reg No 35,952

Dated: 3/15/02

By: [signature]
Richard L. Mayer
(Reg. No. 22,490)

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Substitute Specification

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[10191/2266]

ELECTRONICALLY COMMUTABLE MOTOR HAVING OVERLOAD PROTECTION

Field Of The Invention

The present invention relates to an electronically commutable motor whose output stages are controllable by an electronic control unit, using PWM signals, and are feedable from a supply voltage source.

Background Information

In motors of this type, the electronic control unit supplies power to the motor output stages, which ordinarily include semiconductor switches and windings. The control unit is usually designed for bidirectional operating conditions. If the motor drives a fan, for example, the current rises in proportion to the squared motor speed, while the motor speed rises in linear proportion to the supply voltage. If fans of this type are used in a motor vehicle and fed from the vehicle battery, the motors are designed for a nominal voltage of 13 V, for example, but must operate dependably at a voltage of up to 16V, for example. The fan must provide the necessary air capacity at the nominal voltage. The higher air capacity available at higher battery voltages is therefore superfluous. However, these stipulations mean that the motor and the electronic components must be designed for higher performance ratings around 16V.

Summary Of The Invention

An object of the present invention is to provide an electronically commutable motor that is designed so that its electronic components are limited to the load specified by the nominal voltage and are protected against overloading even when the supply voltage exceeds the nominal voltage.

This object is achieved according to the present invention by enabling the pulse

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width of the PWM control signals for the output stages to be reduced, at least upon exceeding the motor nominal voltage, to a width that prevents overloading of the motor and electronic components by limiting the motor output, as a function of the magnitude of the supply voltage and the specified setpoint for the PWM control signals.

By influencing the PWM control signals for the motor output stages in this manner, the maximum load is defined by the nominal voltage and the maximum setpoint and cannot increase any further even with high supply voltages. The motor and its electronic components therefore need to be designed only for this load and are protected against overloads.

A design of this type also enables the pulse width to be reduced in such a way that the pulse width is reduced in linear or nonlinear proportion to the rising supply voltage; however, it is also possible for the pulse width to decrease at an increasing rate with an increasing specified setpoint and rising supply voltage. This latter instance advantageously makes use of the fact that a smaller specified setpoint reduces the load on the motor and its components, due to lower currents.

According to one embodiment, the pulse width reduction may be incorporated into the control unit by assigning the control unit a correction unit that forwards, to the motor output stages, the PWM control signals for the motor output stages determined according to the specified setpoint, either unchanged or as reduced PWM control signals, as a function of the magnitude of the supply voltage; and by enabling the PWM control signals for the motor output stages determined by the control unit on the basis of the specified setpoint to be forwarded unchanged to the output stages until the motor nominal voltage is reached, with their pulse width being reduced according to the setting provided by the correction unit only when the supply voltage begins to increase.

The correction unit may be integrated into the control unit. In this case, the control unit delivers, to the motor end stages, the PWM control signals, either unchanged or with a reduced pulse width, as a function of the magnitude of the supply voltage.

With this protective circuit, it is possible to detect the motor speed instead of the supply voltage and use it to reduce the pulse width of the PWM control signals. According to the present invention, both values – the supply voltage and the speed – are used to reduce the pulse width of the PWM control signals.

Brief Description Of The Drawings

Figure 1 shows a block diagram of the control unit of an electronically commutable motor with a reduction in the pulse width of the PWM control signals.

Figure 2 shows the motor characteristics with power limiting.

Figure 3 shows the PWM control signal with a normal and reduced pulse width.

Figure 4 shows the pulse width variation as a function of the supply voltage.

Figure 5 shows the pulse width variation as a function of the supply voltage with different specified setpoints for the PWM control signals.

Detailed Desciption

Figure 1 shows a schematic representation of the main units of the electronically commutable motor according to the present invention. However, this does not represent a design delimitation, but serves merely to explain the functions.

Control unit STE is provided with a setpoint $PWM_{setpoint}$ for the PWM control signals of the motor. The setpoint may be specified manually, for example using a potentiometer, and serves to specify a higher or lower speed for the fan driven by

the motor. The motor characteristic, indicated by function PWM_{end} = f ($PWM_{setpoint}$), is stored in control unit STE, where PWM_{end} represents the PWM control signal for output stages EST of the motor and specifies pulse width ID of the control signal according to Figure 3.

As shown in Figure 2, this yields different motor characteristics I-f (M) and N = f (M) for nominal voltage U_{nom} = 13 V and maximum supply voltage U_{max} = 16 V, where I = current, M = torque, and N = speed. Maximum working point A1 having maximum speed N1, maximum current I1 and maximum torque M1 is specified as the load limit value at nominal voltage U_{nom}. An increase in the supply voltage to maximum value U_{max} would yield a maximum working point A2 having maximum current I2, maximum speed N2 and maximum torque M2. To avoid having to design the motor and its electronic components for these maximum loads, activation of output stages EST of the motor is corrected, as indicated by correction unit KE in Figure 1. Value PWM_{end} for the PWM signal of output stages EST determined by control unit STE for setpoint $PWM_{setpoint}$ is modified by correction unit KE so that working point A2 returns to working point A1.

This takes place as a function of the magnitude of supply voltage U_{batt}, as indicated by PWM control signal PWM'_{end} output by correction unit KE. As shown in Figure 3, pulse width ID is reduced to pulse width ID' in linear (a) or nonlinear (b) proportion to the further rise in supply voltage U_{batt}, more or less shortly after nominal voltage U_{nom} is exceeded, as shown in Figure 4.

The degree of reduction may also vary in conjunction with specified setpoint $PWM_{setpoint}$, as shown in Figure 5. With a small setpoint $PWM_{setpoint}$, the reduction decreases more gradually than with a larger setpoint, as indicated in Figure 5 by the different curves of reduced pulse widths ID' of PWM control signals PWM'_{end} as a function of supply voltage U_{batt}.

Note, in addition, that pulse width ID may be corrected by control unit STE itself, and speed N may be used instead of supply voltage U_{batt} and/or in addition to supply voltage U_{batt} as the parameter for reducing pulse width ID.

Abstract Of The Disclosure

Electronically commutable motor whose output stages are controllable by an electronic control unit, using PWM control signals, and are feedable from a supply voltage source. A limitation to a maximum load with overload protection is achieved, at least upon exceeding the nominal voltage of the motor, by reducing the pulse width of the PWM control signals for the output stages to a width that prevents overloading of the motor and electronic components by limiting the motor output, as a function of the magnitude of the supply voltage and the specified setpoint for the PWM control signals.

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ELECTRONICALLY COMMUTABLE MOTOR HAVING OVERLOAD PROTECTION

[Background Information] Field Of The Invention

The present invention relates to an electronically commutable motor whose output stages are controllable by an electronic control unit, using PWM signals, and are feedable from a supply voltage source.

Background Information

In motors of this type, the electronic control unit supplies power to the motor output stages, which ordinarily include semiconductor switches and windings. The control unit is usually designed for bidirectional operating conditions. If the motor drives a fan, for example, the current rises in proportion to the squared motor speed, while the motor speed rises in linear proportion to the supply voltage. If fans of this type are used in a motor vehicle and fed from the vehicle battery, the motors are designed for a nominal voltage of 13 V, for example, but must operate dependably at a voltage of up to 16V, for example. The fan must provide the necessary air capacity at the nominal voltage. The higher air capacity available at higher battery voltages is therefore superfluous. However, these stipulations mean that the motor and the electronic components must be designed for higher performance ratings around 16V.

Summary Of The Invention

An [The] object of the present invention is to provide an electronically commutable motor [of the type mentioned in the preamble] that is designed so that its electronic components are limited to the load specified by the nominal voltage and are protected against overloading even when the supply voltage exceeds the nominal voltage.

MARKED-UP VERSION OF SUBSTITUTE SPECIFICATION

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This object is achieved according to the present invention by enabling the pulse width of the PWM control signals for the output stages to be reduced, at least upon exceeding the motor nominal voltage, to a width that prevents overloading of the motor and electronic components by limiting the motor output, as a function of the magnitude of the supply voltage and the specified setpoint for the PWM control signals.

By influencing the PWM control signals for the motor output stages in this manner, the maximum load is defined by the nominal voltage and the maximum setpoint and cannot increase any further even with high supply voltages. The motor and its electronic components therefore need to be designed only for this load and are protected against overloads.

A design of this type also enables the pulse width to be reduced in such a way that the pulse width is reduced in linear or nonlinear proportion to the rising supply voltage; however, it is also possible for the pulse width to decrease at an increasing rate with an increasing specified setpoint and rising supply voltage. This latter instance advantageously makes use of the fact that a smaller specified setpoint reduces the load on the motor and its components, due to lower currents.

According to one embodiment, the pulse width reduction may be incorporated into the control unit by assigning the control unit a correction unit that forwards, to the motor output stages, the PWM control signals for the motor output stages determined according to the specified setpoint, either unchanged or as reduced PWM control signals, as a function of the magnitude of the supply voltage; and by enabling the PWM control signals for the motor output stages determined by the control unit on the basis of the specified setpoint to be forwarded unchanged to the output stages until the motor nominal voltage is reached, with their pulse width being reduced according to the setting provided by the correction unit only when the supply voltage begins to increase.

The correction unit may be integrated into the control unit. In this case, the control unit delivers, to the motor end stages, the PWM control signals, either unchanged or with a reduced pulse width, as a function of the magnitude of the supply voltage.

With this protective circuit, it is possible to detect the motor speed instead of the supply voltage and use it to reduce the pulse width of the PWM control signals. According to the present invention, both values – the supply voltage and the speed – are used to reduce the pulse width of the PWM control signals.

[The present invention is explained in greater detail below on the basis of an embodiment illustrated in the drawing, where] Brief Description Of The Drawings

Figure 1 shows a block diagram of the control unit of an electronically commutable motor with a reduction in the pulse width of the PWM control signals[;].

Figure 2 shows the motor characteristics with power limiting[;].

Figure 3 shows the PWM control signal with a normal and reduced pulse width[;].

Figure 4 shows the pulse width variation as a function of the supply voltage[; and].

Figure 5 shows the pulse width variation as a function of the supply voltage with different specified setpoints for the PWM control signals.

Detailed Desciption

Figure 1 shows a schematic representation of the main units of the electronically commutable motor according to the present invention. However, this does not represent a design delimitation, but serves merely to explain the functions.

Control unit STE is provided with a setpoint $PWM_{setpoint}$ for the PWM control signals of the motor. The setpoint may be specified manually, for example using a

potentiometer, and serves to specify a higher or lower speed for the fan driven by the motor. The motor characteristic, indicated by function $PWM_{end} = f (PWM_{setpoint})$, is stored in control unit STE, where PWM_{end} represents the PWM control signal for output stages EST of the motor and specifies pulse width ID of the control signal according to Figure 3.

As shown in Figure 2, this yields different motor characteristics I-f (M) and N = f (M) for nominal voltage U_{nom} = 13 V and maximum supply voltage U_{max} = 16 V, where I = current, M = torque, and N = speed. Maximum working point A1 having maximum speed N1, maximum current I1 and maximum torque M1 is specified as the load limit value at nominal voltage U_{nom}. An increase in the supply voltage to maximum value U_{max} would yield a maximum working point A2 having maximum current I2, maximum speed N2 and maximum torque M2. To avoid having to design the motor and its electronic components for these maximum loads, activation of output stages EST of the motor is corrected, as indicated by correction unit KE in Figure 1. Value PWM_{end} for the PWM signal of output stages EST determined by control unit STE for setpoint $PWM_{setpoint}$ is modified by correction unit KE so that working point A2 returns to working point A1.

This takes place as a function of the magnitude of supply voltage U_{batt}, as indicated by PWM control signal PWM'_{end} output by correction unit KE. As shown in Figure 3, pulse width ID is reduced to pulse width ID' in linear (a) or nonlinear (b) proportion to the further rise in supply voltage U_{batt}, more or less shortly after nominal voltage U_{nom} is exceeded, as shown in Figure 4.

The degree of reduction may also vary in conjunction with specified setpoint $PWM_{setpoint}$, as shown in Figure 5. With a small setpoint $PWM_{setpoint}$, the reduction decreases more gradually than with a larger setpoint, as indicated in Figure 5 by the different curves of reduced pulse widths ID' of PWM control signals PWM'_{end} as a function of supply voltage U_{batt}.

MARKED-UP VERSION OF SUBSTITUTE SPECIFICATION

Note, in addition, that pulse width ID may be corrected by control unit STE itself, and speed N may be used instead of supply voltage U_{batt} and/or in addition to supply voltage U_{batt} as the parameter for reducing pulse width ID.

Abstract Of The Disclosure

Electronically commutable motor whose output stages are controllable by an electronic control unit, using PWM control signals, and are feedable from a supply voltage source. A limitation to a maximum load with overload protection is achieved, at least upon exceeding the nominal voltage of the motor, by reducing the pulse width of the PWM control signals for the output stages to a width that prevents overloading of the motor and electronic components by limiting the motor output, as a function of the magnitude of the supply voltage and the specified setpoint for the PWM control signals.

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ELECTRONICALLY COMMUTABLE MOTOR HAVING OVERLOAD PROTECTION

Background Information

The present invention relates to an electronically commutable motor whose output stages are controllable by an electronic control unit, using PWM signals, and are feedable from a supply voltage source.

In motors of this type, the electronic control unit supplies power to the motor output stages, which ordinarily include semiconductor switches and windings. The control unit is usually designed for bidirectional operating conditions. If the motor drives a fan, for example, the current rises in proportion to the squared motor speed, while the motor speed rises in linear proportion to the supply voltage. If fans of this type are used in a motor vehicle and fed from the vehicle battery, the motors are designed for a nominal voltage of 13 V, for example, but must operate dependably at a voltage of up to 16V, for example. The fan must provide the necessary air capacity at the nominal voltage. The higher air capacity available at higher battery voltages is therefore superfluous. However, these stipulations mean that the motor and the electronic components must be designed for higher performance ratings around 16V.

The object of the present invention is to provide an electronically commutable motor of the type mentioned in the preamble that is designed so that its electronic components are limited to the load specified by the nominal voltage and are protected against overloading even when the supply voltage exceeds the nominal voltage.

This object is achieved according to the present invention by enabling the pulse width of the PWM control signals for the output stages to be reduced, at least upon

exceeding the motor nominal voltage, to a width that prevents overloading of the motor and electronic components by limiting the motor output, as a function of the magnitude of the supply voltage and the specified setpoint for the PWM control signals.

By influencing the PWM control signals for the motor output stages in this manner, the maximum load is defined by the nominal voltage and the maximum setpoint and cannot increase any further even with high supply voltages. The motor and its electronic components therefore need to be designed only for this load and are protected against overloads.

A design of this type also enables the pulse width to be reduced in such a way that the pulse width is reduced in linear or nonlinear proportion to the rising supply voltage; however, it is also possible for the pulse width to decrease at an increasing rate with an increasing specified setpoint and rising supply voltage. This latter instance advantageously makes use of the fact that a smaller specified setpoint reduces the load on the motor and its components, due to lower currents.

According to one embodiment, the pulse width reduction may be incorporated into the control unit by assigning the control unit a correction unit that forwards, to the motor output stages, the PWM control signals for the motor output stages determined according to the specified setpoint, either unchanged or as reduced PWM control signals, as a function of the magnitude of the supply voltage; and by enabling the PWM control signals for the motor output stages determined by the control unit on the basis of the specified setpoint to be forwarded unchanged to the output stages until the motor nominal voltage is reached, with their pulse width being reduced according to the setting provided by the correction unit only when the supply voltage begins to increase.

The correction unit may be integrated into the control unit. In this case, the control unit delivers, to the motor end stages, the PWM control signals, either unchanged or

with a reduced pulse width, as a function of the magnitude of the supply voltage.

With this protective circuit, it is possible to detect the motor speed instead of the supply voltage and use it to reduce the pulse width of the PWM control signals. According to the present invention, both values – the supply voltage and the speed – are used to reduce the pulse width of the PWM control signals.

The present invention is explained in greater detail below on the basis of an embodiment illustrated in the drawing, where

Figure 1 shows a block diagram of the control unit of an electronically commutable motor with a reduction in the pulse width of the PWM control signals;

Figure 2 shows the motor characteristics with power limiting;

Figure 3 shows the PWM control signal with a normal and reduced pulse width;

Figure 4 shows the pulse width variation as a function of the supply voltage; and

Figure 5 shows the pulse width variation as a function of the supply voltage with different specified setpoints for the PWM control signals.

Figure 1 shows a schematic representation of the main units of the electronically commutable motor according to the present invention. However, this does not represent a design delimitation, but serves merely to explain the functions.

Control unit STE is provided with a setpoint $PWM_{setpoint}$ for the PWM control signals of the motor. The setpoint may be specified manually, for example using a potentiometer, and serves to specify a higher or lower speed for the fan driven by

the motor. The motor characteristic, indicated by function PWM_{end} = f ($PWM_{setpoint}$), is stored in control unit STE, where PWM_{end} represents the PWM control signal for output stages EST of the motor and specifies pulse width ID of the control signal according to Figure 3.

As shown in Figure 2, this yields different motor characteristics I-f (M) and N = f (M) for nominal voltage U_{nom} = 13 V and maximum supply voltage U_{max} = 16 V, where I = current, M = torque, and N = speed. Maximum working point A1 having maximum speed N1, maximum current I1 and maximum torque M1 is specified as the load limit value at nominal voltage U_{nom}. An increase in the supply voltage to maximum value U_{max} would yield a maximum working point A2 having maximum current I2, maximum speed N2 and maximum torque M2. To avoid having to design the motor and its electronic components for these maximum loads, activation of output stages EST of the motor is corrected, as indicated by correction unit KE in Figure 1. Value PWM_{end} for the PWM signal of output stages EST determined by control unit STE for setpoint $PWM_{setpoint}$ is modified by correction unit KE so that working point A2 returns to working point A1.

This takes place as a function of the magnitude of supply voltage U_{batt}, as indicated by PWM control signal PWM'_{end} output by correction unit KE. As shown in Figure 3, pulse width ID is reduced to pulse width ID' in linear (a) or nonlinear (b) proportion to the further rise in supply voltage U_{batt}, more or less shortly after nominal voltage U_{nom} is exceeded, as shown in Figure 4.

The degree of reduction may also vary in conjunction with specified setpoint $PWM_{setpoint}$, as shown in Figure 5. With a small setpoint $PWM_{setpoint}$, the reduction decreases more gradually than with a larger setpoint, as indicated in Figure 5 by the different curves of reduced pulse widths ID' of PWM control signals PWM'_{end} as a function of supply voltage U_{batt}.

Note, in addition, that pulse width ID may be corrected by control unit STE itself, and

speed N may be used instead of supply voltage U_{batt} and/or in addition to supply voltage U_{batt} as the parameter for reducing pulse width ID.

What is claimed is

1. An electronically commutable motor whose output stages are controllable by an electronic control unit, using PWM control signals, and are feedable from a supply voltage source,
wherein, at least upon exceeding the nominal voltage (U_{nom} = 13 V) of the motor, the pulse width (ID) of the PWM control signals (PWM'_{end}) for the output stages (EST) are reducible to a width (ID) that prevents overloading the motor and electronic components by limiting the motor output, as a function of the magnitude of the supply voltage (U_{batt}) and the specified setpoint ($PWM_{setpoint}$) for the PWM control signals.

2. The electronically commutable motor according to Claim 1,
wherein the pulse width (ID') is reduced in linear or nonlinear proportion to the rising supply voltage (U_{batt}) (Figure 4).

3. The electronically commutable motor according to Claim 1 or 2,
wherein the pulse width (ID') is reduced at an increasing rate in proportion to the increasing specified setpoint ($PWM_{setpoint}$) and rising supply voltage (U_{batt}) (Figure 5).

4. The electronically commutable motor according to one of Claims 1 through 3,
wherein the control unit (STE) is assigned a correction unit (KE) that delivers, to the motor output stages (EST), the PWM control signals (PWM_{end}) for the motor output stages (EST) determined according to the specified setpoint ($PWM_{setpoint}$), either unchanged or as reduced PWM control signals (PWM'_{end}), as a function of the magnitude of the supply voltage (U_{batt}).

5. The electronically commutable motor according to Claim 4,
wherein the PWM control signals (PWM_{end}) determined for the motor output stages (EST) by the control unit (STE) on the basis of the specified setpoint ($PWM_{setpoint}$) may be forwarded unchanged to the output stages until reaching the nominal

voltage (U_{nom}) of the motor, with the pulse width (ID') being reduced according to the setting provided by the correction unit (KE) only when the supply voltage (U_{batt}) begins to increase.

6. The electronically commutable motor according to Claim 4 or 5, wherein the correction unit (KE) is integrated into the control unit (STE), which delivers the PWM control signals (PWM_{end} and PWM'_{end}, respectively) to the output stages (EST) of the motor (M) either unchanged or with a reduced pulse width (ID'), as a function of the magnitude of the supply voltage (U_{batt}).

7. The electronically commutable motor according to one of Claims 1 through 6, wherein the reduction in the pulse width (ID') of the PWM control signals (PWM'_{end}) for the output stages (EST) of the motor (M) takes place as a function of the speed (N) of the motor (M).

Abstract

Electronically commutable motor whose output stages are controllable by an electronic control unit, using PWM control signals, and are feedable from a supply voltage source. A limitation to a maximum load with overload protection is achieved, at least upon exceeding the nominal voltage of the motor, by reducing the pulse width of the PWM control signals for the output stages to a width that prevents overloading of the motor and electronic components by limiting the motor output, as a function of the magnitude of the supply voltage and the specified setpoint for the PWM control signals.

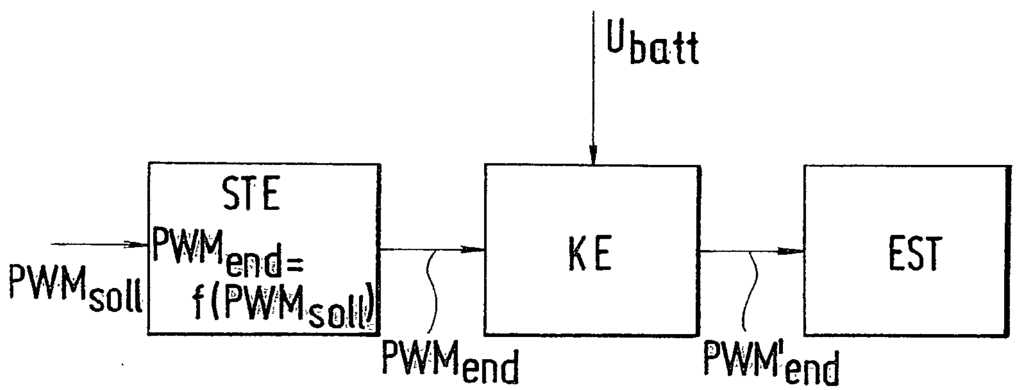
Ubatt
STE
PWMend=
f(PWMsoll)
PWMsoll
KE
EST
PWMend
PWM'end

Fig.1

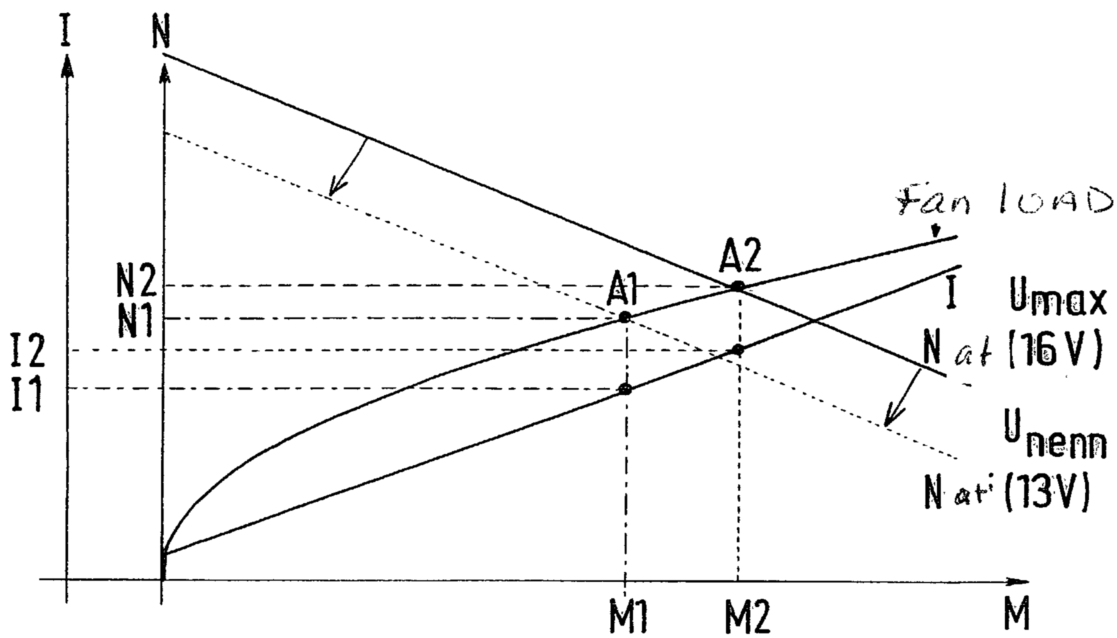
I
N
Fan LOAD
A2
A1
N2
N1
I2
I1
I
Umax
Nat (16V)
Unenn
Nati (13V)
M1
M2
M

Fig. 2

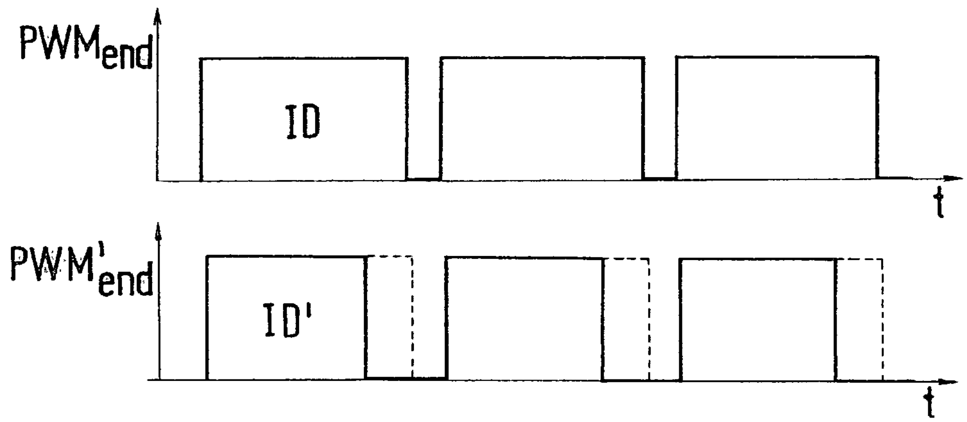

Fig.3

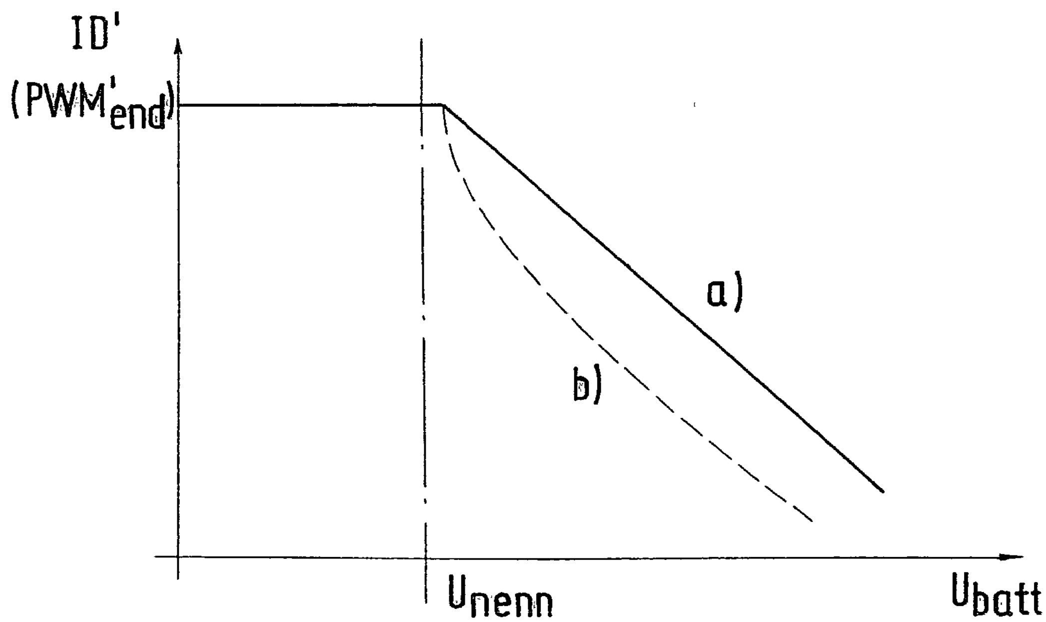

Fig.4

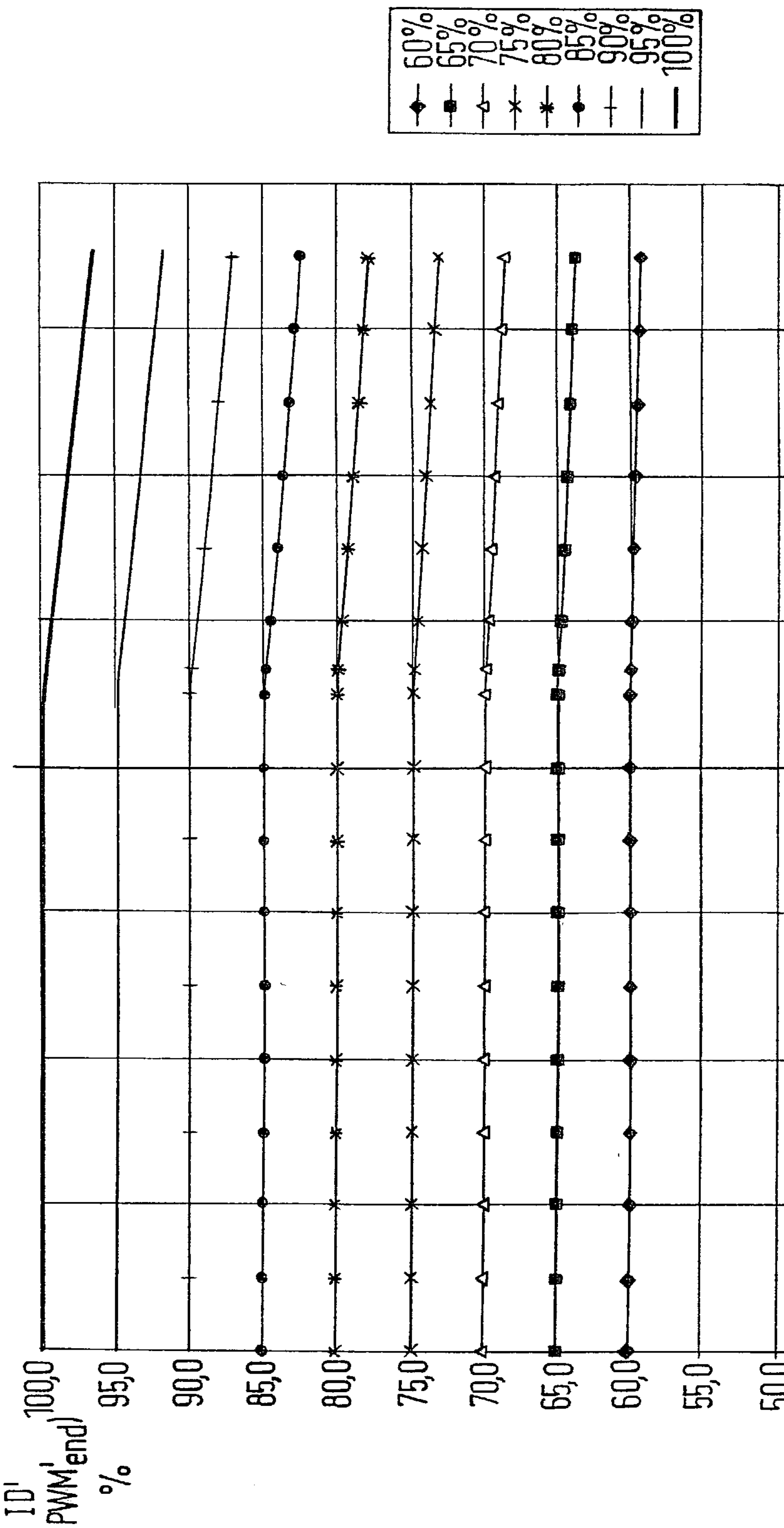
60%
65%
70%
75%
80%
85%
90%
95%
100%
ID'
(PWM'end)
%
100,0
95,0
90,0
85,0
80,0
75,0
70,0
65,0
60,0
55,0
50,0
9,0V
10,0V
11,0V
12,0V
13,0V
14,0V
15,0V
16,0V
17,0V
Ubatt (V)

Fig.5

10191/2266

COMBINED DECLARATION AND
POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **"ELECTRONICALLY COMMUTABLE MOTOR HAVING OVERLOAD PROTECTION"**, and the specification of which:

[ ] is attached hereto;

[ ] was filed as United States Application Serial No. _________ on _________, ____ and was amended by the Preliminary Amendment filed on ____________, ____.

[X] was filed as PCT International Application Number PCT/DE00/03055, on the 6th day of September 2000.

[X] an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

~~EL594613198~~
EL039820580

PRIOR FOREIGN/PCT APPLICATION(S)
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119

Country : Germany

Application No. : 199 44 194.4

Date of Filing: September 15, 1999

Priority Claimed
Under 35 U.S.C. § 119 : [X] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code § 120 of any United States Application or PCT International Application designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR
PCT INTERNATIONAL APPLICATIONS
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. § 120

U.S. APPLICATIONS

Number :

Filing Date :

PCT APPLICATIONS
DESIGNATING THE U.S.

PCT Number :

PCT Filing Date :

I hereby appoint the following attorney(s) and/or agents to prosecute the above-identified application and transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

10008270.071702

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